

## CLAIMS

1. An optical phase delay device for providing phase delayed optical outputs comprising:  
at least two parallel covering plates having a physical separation in between;  
regions of polymer materials spaced by a distance substantially smaller than one micrometer;  
regions of liquid crystal particles interleaving the said regions of polymers;  
and a group of electrodes being fabricated near the said covering glass plates.
2. The optical phase delay device recited in claim 1 wherein the said covering plates being glass plates.
3. The optical phase delay device recited in claim 1 wherein the said liquid crystal regions having an ordinary refractive index  $n_o$  and an extraordinary refractive index  $n_e$ .
4. The optical phase delay device recited in claim 1 wherein the said polymer regions having an index of refraction  $n_p$ .
5. The optical phase delay device recited in claim 1 wherein the said polymer regions and liquid crystal regions being fabricated through a photolithography method.
6. The optical phase delay device recited in claim 1 wherein the said liquid crystal regions containing liquid crystal materials.
7. The optical phase delay device recited in claim 1 wherein the said polymer regions and liquid crystal regions being fabricated through a photolithography method using patterned phase masks and/or using patterned holographic two beam interference methods.
8. The optical phase delay device recited in claim 1 wherein the said electrodes being fabricated with electrically conductive materials such as metals, ITO (Indium-Tin oxide), and/or conductive polymeric mixtures.
9. The optical phase delay device recited in claim 1 wherein the said electrodes being fabricated through a photolithography method.

10. The optical phase delay device recited in claim 1 wherein the said cover plate being optically coupled to at least one polarization beam splitters.
11. The optical phase delay device recited in claim 1 wherein the said cover plate being optically coupled to at least one prism.
12. The optical phase delay device recited in claim 1 wherein the said polymer regions having separations measuring from 1 to 1000 nanometers.
13. The optical phase delay device recited in claim 1 wherein the said cover plates having a separation distance of 1 micrometers to 500 micrometers.
14. A method for providing optical phase delay comprising the following steps:
  - using a collimated light source having specific wavelength;
  - passing the input light to an electrically tuned liquid crystal nano-structure consisting of alternating polymer and liquid crystal regions;
  - applying electrical voltages to electrodes near the said liquid crystal nano-structure to tune the said optical phase delay.
15. The method recited in claim 14 wherein the said liquid crystal regions having an ordinary refractive index  $n_o$  and an extraordinary refractive index  $n_e$ .
16. The method recited in claim 14 wherein the said polymer regions having an index of refraction  $n_p$ .
17. The method recited in claim 14 wherein the said polymer regions and liquid crystal regions being fabricated through a photolithography method.
18. The method recited in claim 14 wherein the said liquid crystal regions containing liquid crystal materials.
19. The method recited in claim 14 wherein the said polymer regions and liquid crystal regions being fabricated through a photolithography method using patterned phase masks and/or using holographic two beam interference methods.
20. The method recited in claim 14 wherein the said the said electrodes being fabricated with electrically conductive materials such as metals, ITO (Indium-Tin oxide), and/or conductive polymeric mixtures.

21. The method recited in claim 14 wherein the said liquid crystal regions being optically coupled to at least one polarization beam splitters.
22. The method recited in claim 14 wherein the said polymer regions having separations measuring from 1 to 1000 nanometers.
23. The method recited in claim 14 wherein the said cover plates having a separation distance of 1 micrometers to 500 micrometers.